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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/500,772	07/06/2004	Peter Stephenson	fraunh01.033	7034

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EXAMINER	
BROOME, SAID A	
ART UNIT	**PAPER NUMBER**
2628	

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Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 10/03)

Office Action Summary	Application No.	Applicant(s)	
	10/500,772	STEPHENSON, PETER	
	Examiner	Art Unit	
	Said Broome	2671	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *07 January 2002*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-18* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-18* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 101

35 U.S.C. 101 reads as follows:

> Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

Claims 1-18 are rejected under 35 U.S.C. 101 because the claimed invention is directed to non-statutory subject matter. The claim describes a method practiced in a computer system of determining voxels in an object space that are traversed with a ray to determine intersections with the ray however, no useful, concrete and tangible result is produced because the data is not used to provide a generated display or other indication of resulting detected intersections. Therefore, the claimed invention does not posses "real world" value, and instead represents nothing more than a process of determining intersections.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1, 2, 10 and 11 are rejected under 35 U.S.C. 102(b) as being anticipated by Schroder et al. ("Data Parallel Volume Rendering as Line Drawing").

Regarding claim 1, Schroder et al. describes making projections of the ray on a plurality of planes in the object space(on page 25 first column first paragraph lines 2-9 "...line drawing to traverse the data set when evaluating the path integrals corresponding to a raytracing of the

volume...:rays of a parallel projection correspond to a single line instance multiple times across the viewing plane...", and the ray is also shown projected through several planes in the object space in Figure 3); determining cells in the planes that are intersected by the projections (Figure 1, "All rays start from the image "line" and are chosen such that they intersect the outermost column of pixels...Each ray enumerates the voxels it steps through."); and using the intersected cells to determine the intersected voxels(section 2 second paragraph lines 2-7, "Each ray starts in the image line(plane) and steps toward the volume...rays will enter the frontmost column(face) of the image (volume) with the same pixel(voxel) coordinate.") and on page 29 first column third paragraph line 8("...the intersections are evaluated...").

Regarding claim 2, Schroder et al. illustrates determining a set of runs of cells, which are rows of pixels containing the same y coordinate, that are intersected by the projection of the ray in Figure 1.

Regarding claim 10, Schroder illustrates an object space that has a major axis relative to the ray in Figure 1. Schroder also describes a plurality of planes as two planes which intersect along the major axis, as shown in Figure 6, where it is shown that the frontmost face of the cell is contained on one plane of the major axis and intersects the rightmost face is contained on another plane of the major axis at the bottom right point of the voxel.

Regarding claim 11, Schroder illustrates in Figure 6 two planes, one of the frontmost face of the cell along the major axis and one of the rightmost face along the major axis, where the planes are shown to intersect at right angles.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 3 and 6 are rejected under 35 U.S.C. 103(a) as being unpatentable over Schroder et al. ("Data Parallel Volume Rendering as Line Drawing") in view of Stephenson et al.("Why Step When You Can Run?").

Regarding claim 3, Schroder et al. fails to teach runs that have an order greater than 1. Stephenson et al. illustrates runs that have an order greater than 1 in Figure 4 where runs of order 2 are shown. It would have been obvious to one of ordinary skill in the art to combine the teachings of Schroder et al. and Stephenson et al. because this combination would provide more efficient analysis of the line by using higher orders than 1.

Regarding claim 6, Schroder et al. describes a set of runs for a given projection are determined in parallel (on page 25 first column first paragraph lines 2-9 "...line drawing to traverse the data set when evaluating the path integrals corresponding to a raytracing of the volume...rays of a parallel projection correspond to a single line instance multiple times across the viewing plane..."), and it is also illustrated in Figure 1. However, Schroder et al. fails to teach determining a set of runs for a given projection in parallel. Stephenson et al. describes determining a set of runs for a given projection in parallel on page 83 second column fifth paragraph lines 2-4("line drawing and ray traversal through a 2D lattice, producing both

sequential and parallel algorithms"), and is also illustrated in Figure 4. It would have been obvious to one of ordinary skill in the art to combine the teachings of Schroder et al. and Stephenson et al. because this combination would provide the ability to investigate several ray intersections.

Claims 7-9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Schroder et al. in view of Kaufman et al.(US Patent 5,442,733).

Regarding claim 7, Schroder et al. fails to teach the step of using the intersected cells to determine the intersected voxels further includes the step of determining whether the intersected voxels are edge-connected or corner-connected. Kaufman et al. teaches in column 6 lines 14-18("The three kinds of neighboring voxels defined above can be specified in terms of whether voxels share a face (i.e., a surface), a side (i.e., edge) or a corner (i.e., a point) with a neighboring voxel..."), where it is described that intersected voxels may be determined to be either edge-connected or corner-connected. It would have been obvious to one of ordinary skill in the art to combine the teachings of Schroder et al. and Kaufman et al. because this combination would provide accurate calculation of the position at which voxels touch each other thereby providing which regions of the volume data contain contents of an object.

Regarding claim 8, Schroder et al. fails to teach in the step of determining whether the intersected voxels are edge-connected or corner connected, if one of the first-order runs of cells has a corner connection at a point and the other first order run of cells does not have a corner connection at the corresponding point, the intersected voxels have an edge connection at the corresponding point. Kaufman teaches in the step of determining whether the intersected voxels

are edge-connected or corner connected, if one of the first-order runs of cells has a corner connection at a point and the other first order run of cells does not have a corner connection at the corresponding point, the intersected voxels have an edge connection at the corresponding point in Figure 2B, where it is shown that cells that cells do not have corner connections, and are therefore edge connecting, as described in column 4 lines 7-8 ("FIG. 2B is a schematic representation of some voxels that share a edge") and column 6 lines 14-18 ("The three kinds of neighboring voxels defined above can be specified in terms of whether voxels share a face (i.e., a surface), a side (i.e., edge) or a corner (i.e., a point) with a neighboring voxel…"). The motivation to combine the teachings of Schroder et al. and Kaufman is equivalent to the motivation of claim 7.

Regarding claim 9, Schroder et al. fails to teach in the step of determining whether the intersected voxels are edge-connected or corner connected, if both of the first-order runs of cells have corner connections at a corresponding point, the intersected voxels have a corner connection at the corresponding point. Kaufman illustrates if both of the first-order runs of cells have corner connections at a corresponding point, the intersected voxels have a corner connection at the corresponding point in Figure 2C, and is described in column 4 lines 9-10 ("FIG. 2C is a schematic representation of some voxels that share a corner ")and column 6 lines 14-18 ("The three kinds of neighboring voxels defined above can be specified in terms of whether voxels share a face (i.e., a surface), a side (i.e., edge) or a corner (i.e., a point) with a neighboring voxel…"). The motivation to combine the teachings of Schroder et al. and Kaufman is equivalent to the motivation of claim 7.

Claims 12-14 and 16-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lacroute et al.("Fast Volume Rendering Using a Shear-Warp Factorization of the Viewing Transformation") in view of Schroder et al.

Regarding claim 12, Lacroute et al. teaches all the limitations except a method practiced in a computer system of traversing a volume with a particular ray of a plurality thereof and a volume being subdivided into first runs of voxels. Lacroute et al. teaches certain voxels associated with data that affects rays, such as the determination of whether the voxels are transparent, as shown in Figure 5 and as described on page 5 first column second paragraph lines 8-12 ("to render voxels from an unencoded 3D voxel array. The array is traversed scanline by scanline. For each scanline we use the octree and the summed area table to determine which portions of the scanline are non-transparent."). Lacroute et al. also teaches a ray intersecting one or more of the first runs and being defined as a set of second runs of voxels on page 5 first column step 3 where it is described that an algorithm subdivides the scanline, or row of volume data, therefore the first run, or row of volume data, is defined as a second run of voxels. Lacroute et al. illustrates determining whether the second run includes a voxel of a first run that affects the rays, in Figure 5, where it is shown that a voxel scan lines or first run of voxels, is subdivided into a set of second runs of voxels in which h it is determined which voxels included in the original voxel scanline affect the ray. Lacroute et al. also illustrates that when the second run includes such a voxel, examining the associated data in Figure 4 where it is shown that when it is determined that the particular voxel is visible, it is examined and then skipped("Offsets stored with opaque pixels in the intermediate image allow occluded voxels to be skipped

efficiently"). Again, Lacroute et al. fails to teach a method practiced in a computer system of traversing a volume with a particular ray of a plurality thereof and a volume being subdivided into first runs of voxels. Schroder et al. a method practiced in a computer system of traversing a volume with a particular ray of a plurality thereof (on page 25 first column first paragraph lines 2-9 "The algorithm uses the idiom line drawing to traverse the data set when evaluating the path integrals corresponding to a raytracing of the volume…We have implemented this algorithm on the Princeton Engine (PE) and the Connection Machine CM2 computers…") and a volume being subdivided into first runs of voxels(section 2 second paragraph lines 2-6 "Each ray starts in the image line (plane) and steps towards the volume... all rays will enter the frontmost column (face) of the image (volume) with the same pixel (voxel)…"). It would have been obvious to one of ordinary skill in the art to combine the teachings of Lacroute et al. and Schroder et al. because this combination would provide efficient analysis of voxels that affect a ray, through determining the transparency of the voxels.

Regarding claim 13, Lacroute et al. illustrates first runs containing significant runs that include certain voxels in Figure 5, where it is shown that first runs, or rows of voxels, contain significant runs, which are runs that contain voxels who affect the ray in that they signify which voxels as non-transparent or visible voxels.

Regarding claim 14, Lacroute et al. fails to teach that the volume has an axis that is the major axis for both the particular ray and the first runs of voxels. Schroder et al. teaches the volume, in section 2 second paragraph lines ("…the rays with a spacing in the image line such that their vertical distance is 1 (see Figure 1): then all rays will enter the frontmost column (face) of the image (volume)…"), has an axis that is the major axis for both the particular ray and the

first runs of voxels, as shown in Figure 1. The motivation to combine the teachings of Lacroute et al. and Schroder et al. is equivalent to the motivation of claim 12.

Regarding claim 16, Lacroute et al. teaches aggregate information is associated with partitions of the first runs, the aggregate information associated with a partition indicating how one or more voxels in the partition affect rays in section 3.3 third paragraph lines 1-4("...space into transparent and non-transparent regions, and our goal is to decide quickly which portions of a given scanline contain voxels in the non-transparent regions of the feature space."), where it is described that aggregate information, or data that provides how the voxels affect the ray, is associated with partitioned regions, as illustrated in Figure 4. Lacroute et al. also teaches in the step of determining whether second run includes a voxel of a first run that affects rays, in section 3.3 fourth paragraph steps 2 and 3 respectively("Determine if the region is transparent,...", "Subdivide the scanline and repeat this algorithm recursively..."), where it is described that a voxel scanline or run of voxels is subdivided into a second set of runs where the determination of whether or not the voxels are transparent are recursively determined. Lacroute et al. illustrates the aggregate information associated with a partition, as illustrated in the partitioned voxel scanline of Figure 5, is used to determine whether the partition contains a voxel that affects the particular ray, where it is shown that it determines whether or not the voxel is transparent.

Regarding claim 17, Lacroute et al. illustrates a first run has associated therewith a plurality of sets of partitions, the partitions in each set having a different length in voxels in Figure 5. Lacroute et al. teaches the step of determining includes the step of selecting one of the sets of partitions in accordance with the lengths of the second runs in the particular ray, in section 3.3 fourth paragraph page 5 step 3("If the size of the current scanline portion is below a

threshold then render it instead of subdividing."), where it is described that the lengths of the portioned runs determined which runs are chosen for rendering.

Regarding claim 18, Lacroute et al. teaches aggregate information is associated with the significant runs, the aggregate information associated with the significant run indicating how one or more voxels in the partition affect rays, which are runs that provide information regarding which voxels are transparent, as described in section 3.3 second paragraph lines 3-6 ("...a new method to determine which portions of each scanline are nontransparent...") and third paragraph lines 1-4 ("...partitions a multidimensional feature space into transparent and non-transparent regions..."), and as shown in Figure 5. Lacroute et al. also teaches the step of determining whether second run includes a voxel of a first run that affects rays includes using the aggregate information associated with a significant run to determine whether the significant run contains a voxel that affects the particular ray in Figure 5 where it is shown that a voxel scanline is divided into a set of runs of voxels which are partitioned in terms whether or not they are transparent.

Claim 15 is rejected under 35 U.S.C. 103(a) as being unpatentable over Lacroute et al. in view of Schroder et al. in further view of Cohen-Or et al.("An Incremental Alignment Algorithm for Parallel Volume Rendering").

Regarding claim 15, Lacroute et al. and Schroder et al. fail to teach three sets of first runs, each set thereof having a different axis of the volume as its major axis. Cohen-Or et al. illustrates in Figure 5, sets of runs (a) and (d) each having a different axis(z and x respectively) of the volume(section 4 first paragraph line 4 "The 2D lines are analogs of the rays that traverse the volume in the 3D case.") as its major axis(page 3 section 3 first paragraph line 3 "the volume

data is distributed along the major axis"), and also teaches that the major axis associated with sets of runs, which are rows of pixels, may be changed, as described on page 6 section 5 first paragraph lines 4-6("...difference is caused by the choice of major axis... "). Therefore Cohen-Or et al. also teaches three sets of runs through providing the choice of major axis for a particular set of runs, which would enable a third set containing the y axis as its major axis. It would have been obvious to one of ordinary skill in the art to combine the teachings of Lacroute et al., Schroder et al. and Cohen-Or et al. because this combination would provide separate major axes for three sets of runs thereby enabling an expansive determination of voxel data that affects a ray from any major axis orientation.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Said Broome whose telephone number is (571)272-2931. The examiner can normally be reached on 8:30am-5pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Ulka Chauhan can be reached on (571)272-7782. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

S. Broome SB
3/16/2006

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